

REMARKS

By this Amendment, Claims 9, 10, 41 and 42 are amended, and new Claims 43-61 are added, leaving Claims 1-15 and 39-61 pending in the application. No new matter is added by the claim amendments. Reconsideration of the Official Action is respectfully requested.

Personal Interview

Applicants thank the Examiner for the courtesies extended to Applicants' undersigned representative during the personal interview conducted on May 18, 2004. Applicants' separate record of the substance of the interview is incorporated in the following remarks.

Rejection Under 35 U.S.C. §102

Claims 41 and 42 stand rejected under 35 U.S.C. §102(b) over WO 99/57747 ("Chang"). The reasons for the rejection are stated on pages 2-3 of the Official Action. The rejection is respectfully traversed.

Independent Claim 41, as amended, recites a plasma processing system, which comprises, *inter alia*, "a plasma processing chamber"; "a substrate support on which a substrate is supported within the processing chamber"; "a dielectric member having an interior surface facing the substrate support, the dielectric member forming a wall of the processing chamber"; and "a gas injector body extending through the dielectric member such that a distal end of the gas injector body is exposed within the processing chamber, the gas injector body including a plurality of gas outlets which are disposed within the processing chamber below the interior surface of the dielectric member" (emphasis added). See, for example, page 17, lines 24-26 of the specification, and Figures 2a and 2b, which show embodiments of the claimed

plasma processing system comprising a dielectric window 20 having an interior surface facing a substrate support 12, and a gas injector 22 extending through the dielectric window 20. The gas injectors 22 include an on-axis outlet 24 and off-axis outlets 26, i.e., a plurality of outlets, which are "disposed within the processing chamber below the interior surface of the dielectric member," as recited in Claim 41. In the system recited in Claim 41, the process gases supplied through the first and second gas lines are introduced into the processing chamber below the interior surface of the dielectric member.

The Official Action asserts that Chang discloses a plasma processing system comprising a plasma processing chamber 38, a substrate support 56, a dielectric member 50 having an interior surface facing the substrate support and forming a wall of the processing chamber, and a gas injector extending through the dielectric member such that a distal end of the gas injector body is exposed within the processing chamber. It is further asserted in the Official Action that the gas injector body includes a plurality of gas outlets 96/98, and that the gas injector comprises an injector body including at least first and second gas inlets, at least first and second gas passages, and at least first and second gas outlets, with the first gas passage being in fluid communication with the first inlet and the first outlet, and the second gas passage being in fluid communication with a second inlet and a second outlet, but the first and second gas passages not being in fluid communication with each other. Applicants respectfully submit that Chang fails to disclose the combination of features recited in Claim 41.

Chang discloses a HDP-CVD system 36 comprising a gas delivery system 46. As shown in Figures 1 and 7 of Chang, the gas delivery system 46 includes a top

vent 98 connected to H₂ gas source 100b, and a top nozzle 96 connected to argon gas source 100d and TiCl₄ gas source 100a. See page 9, lines 21-29 of Chang. As explained in the paragraph bridging pages 18 and 19 of Chang, a portion of the flow of hydrogen gas follows substantially the contour of the interior surface of the dome 50. As shown in Figure 7 of Chang, the interior surface of the dome 50 is angled relative to the longitudinal axis of the top nozzle 96 such that the diameter of the opening through the dome 50 through which argon and TiCl₄ flows increases in the direction of the longitudinal axis of the top nozzle 96 and top vent 98.

As shown in Figure 7 of Chang, only the top nozzle extends below the interior surface of the dome 50. The top vent 98 in Figure 7 of Chang is actually an opening through the dome 50. Thus, to the extent that top nozzle 96 and top vent 98 are interpreted to read on part of a "gas injector body," as recited in Claim 41, Chang's alleged "gas injector body" clearly does not include "a plurality of gas outlets which are disposed within the processing chamber below the interior surface of the dielectric member" (emphasis added). Rather, the "gas injector body" includes only a single outlet below the interior surface of the dome 50, i.e., the outlet of the top nozzle 96.

Moreover, Chang provides no motivation to modify the gas delivery system so that the alleged "gas injector body" includes "a plurality of gas outlets which are disposed within the processing chamber below the interior surface of the dielectric member," as recited in Claim 41. As explained above, Chang's top vent 98 is designed specifically such that the hydrogen gas flow follows substantially the contour of the interior surface of the dome 50, i.e., the hydrogen outlet is actually the opening formed in the dome itself and thus the hydrogen outlet cannot extend below

the interior surface of the dome. Thus, the hydrogen gas is not introduced into Chang's plasma processing region 52 below the interior surface of the dome 50. It would thus go against Chang's teachings to modify the "gas injector body" to include any additional gas outlets in the "gas injector body" that also are disposed between the interior surface of the dome 50. Accordingly, the system recited in Claim 41 is patentable over Chang.

Independent Claim 42, as amended, recites a plasma processing system, which comprises, *inter alia*, "a plasma processing chamber"; "a substrate support on which a substrate is processed within the processing chamber"; "a dielectric member having an interior surface facing the substrate support, the dielectric member forming a wall of the processing chamber"; and "gas injector comprising an injector body including at least first and second gas inlets, at least first and second gas passages, an axial end surface, a side surface extending from the axial end surface toward the interior surface of the dielectric member, and at least a first optional gas outlet in the axial end surface and a plurality of second gas outlets in the side surface at locations between the axial end surface and the interior surface of the dielectric member, the first gas passage being in fluid communication with the first inlet and first outlet, and the second gas passage being in fluid communication with the second inlet and second outlet, the first and second gas passages not being in fluid communication with each other" (emphasis added). For example, in the embodiments shown in Figures 2a-2c, off-axis outlets 26 are provided in the side surface of injector 22 between an axial end surface at which optional gas outlet 24 is provided and an interior surface of the dielectric window 20.

Chang fails to disclose the combination of features recited in Claim 42.

Chang's alleged "gas injector body" does not include at least the features of "at least a first optional gas outlet in the axial end surface and a plurality of second gas outlets in the side surface at locations between the axial end surface and the interior surface of the dielectric member" (emphasis added). To the extent that Chang is interpreted such that the top nozzle 96 includes an "axial end surface" and a first gas outlet in the axial end surface, Chang does not disclose the features of "a side surface extending from the axial end surface toward the interior surface of the dielectric member," much less the features of "a plurality of second gas outlets in the side surface at locations between the axial end surface and the interior surface of the dielectric member," as recited in Claim 42. Accordingly, the subject matter recited in Claim 42 also is patentable over Chang.

Therefore, withdrawal of the rejection under 35 U.S.C. §102(b) over Chang is respectfully requested.

Rejections Under 35 U.S.C. §103

A. Claims 1-7, 9, 11-14 and 39 stand rejected under 35 U.S.C. §103(a) over Chang in view of U.S. Patent No. 5,958,140 to Arami et al. ("Arami") or U.S. Patent No. 5,532,190 to Goodyear et al. ("Goodyear") or U.S. Patent No. 6,090,210 to Balance et al. ("Balance"). The reasons for the rejection are stated on pages 3-6 of the Official Action. The rejection is respectfully traversed.

Claim 1 recites a plasma processing system, which comprises, *inter alia*, "a plasma processing chamber"; "a substrate support on which a substrate is processed within the processing chamber"; "a dielectric member having an interior surface facing the substrate support, wherein the dielectric member forms a wall of

the processing chamber"; "a gas injector extending through the dielectric member, the gas injector comprising a body including an axial end surface exposed within the processing chamber, a side surface extending axially from the axial end surface, and a plurality of gas outlets including at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface"; and "a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with the off-axis outlets and the second gas line being in fluid communication with the off-axis outlets but not with the on-axis outlet" (emphasis added).

The Office Action asserts that Chang discloses a plasma processing system comprising a plasma processing chamber 38, a vacuum pump system 40, a substrate support 56, a dielectric number 50 and a gas injector extending through the dielectric number. It is further asserted in the Office Action that the gas injector comprises a body including an axial end-surface exposed within the processing chamber, a side surface that extends axially from the axial end-surface, and a plurality of gas outlets 96/98 including at least one on-axis outlet 96 in the axial end-surface, and a plurality of spaced-apart off-axis outlets 98 in the side surface. It is acknowledged in the Official Action that Chang does not disclose a common gas supply in fluid communication with a first gas line and a second gas line.

To attempt to cure the deficiencies of Chang, the Official Action cites Arami, Goodyear and Balance for their alleged disclosure of an apparatus comprising a gas injecting system in which a common gas supply is in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with a first outlet and a second line connected to second outlets, wherein the first line is in

fluid communication with the first outlet, but not with the second outlets, and the second gas line is in fluid communication with the second outlets, but not with the first outlet. To attempt to cure the deficiencies of Chang and secondary references, the Official Action alleges that it would have been obvious to modify the gas supply system of the apparatus of Chang to comprise a common gas supply in fluid communication with the first gas line and the second gas line, in order to enable the injection of the same gas to the processing chamber through the on-axis outlet and the off-axis outlets. Applicants respectfully disagree with these assertions.

As explained above, Chang fails to disclose or suggest the combination of features recited in Claim 1, which includes "the gas injector comprising a body including an axial end surface exposed within the processing chamber, a side surface extending axially from the axial end surface, and a plurality of gas outlets including at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface" (emphasis added). Arami, Goodyear and Balance each disclose a showerhead-type gas supply. These secondary references fail to disclose or suggest a gas injector comprising the features recited in Claim 1, including "a side surface extending axially from the axial end surface, and a plurality of gas outlets including at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface." Accordingly, the secondary references provide no suggestion or motivation to modify Chang to achieve the combination of features recited in Claim 1.

Moreover, in addition to Chang's failure to disclose the Claim 1 features of "a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with

the off-axis outlets and the second gas line being in fluid communication with the off-axis outlets but not with the on-axis outlet," Chang teaches away from the claimed features. Particularly, Chang discloses at page 4, lines 7-18, that the invention disclosed therein avoids unwanted deposition within the process chamber by employing a bifurcated flow of a titanium gas source and a plasma forming gas. Chang clearly teaches away from a gas supply system construction that supplies the same gas into the process chamber through the top nozzle 96 and top vent 98, because such system would not be able to provide a bifurcated flow of the hydrogen and TiCl₄ into the process chamber. As stated at MPEP § 2145(X)(D)(2), page 2100-157, "[i]t is improper to combine references where the references teach away from their combination. *In re Grasselli*, 713 F.2d 731, 743, 218 USPQ 769, 779 (Fed. Cir. 1983)." For this additional reason, the modification of Chang advanced in the Official Action is improper and the system recited in Claim 1 is patentable over the cited combination of references.

Dependent Claims 2-6, 11-14 and 39 are also patentable over the cited combination of references for at least the same reasons that Claim 1 is patentable.

Independent Claim 7 recites a plasma processing system, which comprises "a plasma processing chamber"; "a substrate support on which a substrate is processed within the processing chamber"; "a dielectric member having an interior surface facing the substrate support, wherein the dielectric member forms a wall of the processing chamber"; and "a gas injector extending through the dielectric member such that a distal end of the gas injector is exposed within the processing chamber, the gas injector including a planar axial end face having an on-axis outlet therein and a conical side surface having off-axis outlets therein, the on-axis outlet

receiving process gas from a central passage in the injector and the off-axis outlets receiving process gas from an annular passage surrounding the central passage, the gas injector supplying process gas at flow rates that are independently varied between at least some of the outlets including the on-axis outlet into the processing chamber" (emphasis added). For reasons explained above, Chang fails to disclose an injector having a conical side surface with outlets in it. For reasons explained above, the secondary references fail to cure the deficiencies of Chang. Thus, the cited references fail to disclose or suggest the combination of features recited in Claim 7, including at least the features of "a gas injector extending through the dielectric member such that a distal end of the gas injector is exposed within the processing chamber, the gas injector including a planar axial end face having an on-axis outlet therein and a conical side surface having off-axis outlets therein."

Accordingly, the system recited in Claim 7 also is patentable.

Claim 12 depends from Claim 7 and thus also is patentable over the cited combination of references for at least the same reasons that Claim 7 is patentable. Moreover, Claim 12 recites the feature of "a common gas supply which supplies gas to the on-axis and off-axis gas outlets," which further patentably distinguishes the claimed system over the cited combination of references.

Claim 9 recites a plasma processing system comprising, *inter alia*, "a plasma processing chamber"; "a substrate support on which a substrate is processed within the processing chamber"; and "a gas injector extending through the dielectric member such that a distal end of the gas injector is exposed within the processing chamber, the gas injector including at least one on-axis outlet which injects process gas in an axial direction perpendicular to a plane parallel to an exposed surface of

the substrate and off-axis gas outlets which inject process gas at an acute angle relative to the plane parallel to the exposed surface of the substrate, the off-axis outlets being circumferentially spaced apart from each other, the gas injector supplying process gas at flow rates that are independently varied between at least some of the outlets into the processing chamber" (emphasis added). As explained above, Chang's alleged "gas injector body" does not include off-axis outlets, but rather includes only one outlet. Nor does Chang suggest modifying the alleged "gas injector body" to include such off-axis outlets. Accordingly, Chang fails to suggest that the alleged "gas injector body" includes off-axis outlets being circumferentially spaced apart from each other," as recited in Claim 9.

The cited secondary references also fail to suggest a gas injector including off-axis gas outlets, as recited in Claim 9, and thus they provide no motivation to modify Chang to result in the claimed system. Thus, the system recited in Claim 9 also is patentable over the cited combination of references.

Therefore, withdrawal of the rejection is respectfully requested.

B. Claims 8, 10 and 40 stand rejected 35 U.S.C. §103(a) over Chang in view of Arami or Goodyear or Ballance, and further in view of WO 00/41212 ("Ni"). The reasons for the rejection are stated on pages 6-7 of the Official Action. The rejection is respectfully traversed.

It is admitted in the Official Action that Chang, Arami, Goodyear and Balance fail to disclose a gas injector that is removably mounted in a dielectric window. However, it is asserted in the Official Action that Ni discloses an apparatus comprising a gas injector removably mounted to a dielectric window, and that it

would have been obvious to modify the apparatus of Chang as modified by Arami, Goodyear or Ballance to removably mount the gas injector to the dielectric window.

Claim 8 depends from Claim 1. Ni fails to cure the deficiencies of Chang and the secondary references with respect to the plasma processing system recited in claim 1. Particularly, Ni discloses a gas injector 22 including gas outlets at the lower axial end (page 11, lines 6-11 and Figure 3A). However, Ni does not suggest modifying Chang's gas injector to achieve the combination of features recited in Claim 1, including the features of "the gas injector comprising a body including an axial end surface exposed within the processing chamber, a side surface extending axially from the axial end surface, and a plurality of gas outlets including at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface" (emphasis added). Accordingly, the plasma processing system recited in Claim 8 is patentable for at least the same reasons that Claim 1 is patentable.

Claim 10 recites a plasma processing system comprising, *inter alia*, "a plasma processing chamber"; "a substrate support on which a substrate is processed within the processing chamber"; "a dielectric member having an interior surface facing the substrate support, wherein the dielectric member forms a wall of the processing chamber" and "a gas injector removably mounted in an opening in the dielectric member and extending through the dielectric member such that a single distal end of the gas injector is exposed within the processing chamber, a vacuum seal being provided between the gas injector and the dielectric window, the gas injector including a plurality of gas outlets in the single distal end which are each located below the interior surface of the dielectric member, the gas outlets supplying process

gas at flow rates that are independently varied between at least some of the outlets into the processing chamber" (emphasis added). For reasons stated above, the combination of Chang and Arami, Goodyear or Balance fails to suggest the combination of features recited in Claim 10, including the features of "the gas injector including a plurality of gas outlets in the single distal end which are each located below the interior surface of the dielectric member such that the gas outlets are immersed within plasma generated in the chamber, the gas outlets supplying process gas at flow rates that are independently varied between at least some of the outlets into the processing chamber."

Ni fails to cure the deficiencies of Chang and the cited secondary references with respect to the system recited in Claim 10. Ni does not suggest modifying Chang to achieve a gas injector that includes a plurality of gas outlets in a single distal end thereof, which are each located below an interior surface of a dielectric member, and wherein the gas outlets supply process gas at flow rates that are independently varied between at least some of the outlets into the processing chamber. Thus, the system recited in Claim 10 also is patentable. Dependent Claim 40 is also patentable for at least the same reasons that Claim 10 is patentable.

Therefore, withdrawal of the rejection is respectfully requested.

C. Claim 15 stands rejected 35 U.S.C. §103(a) over Chang in view of Arami or Goodyear or Balance and further in view of U.S. Patent No. 6,287,643 to Powell et al. ("Powell"). The reasons for the rejection are stated on pages 7-8 of the Official Action. The rejection is respectfully traversed.

The Official Action acknowledges that Chang and Arami, Goodyear or Ballance fail to disclose a gas injector provided with an electrically conducting shield,

as recited in Claim 15. However, it is asserted in the Official Action that Powell discloses an apparatus comprising a gas injection tube 84 provided with an electrically conducting shield and that it would have been obvious to modify the apparatus of Chang, as modified by Arami, Goodyear or Ballance, to further comprise an electrically conducting shield for the gas injector. Applicants respectfully disagree with these assertions.

Powell discloses an apparatus for injecting gas within a plasma reactor. However, Powell provides no motivation to modify Chang's gas injector to include the combination of features recited in Claim 1, including the features of "a gas injector extending through the dielectric member, the gas injector comprising a body including an axial end surface exposed within the processing chamber, a side surface extending axially from the axial end surface, and a plurality of gas outlets including at least one on-axis outlet in the axial end surface and a plurality of spaced-apart off-axis outlets in the side surface" and "a common gas supply in fluid communication with a first gas line and a second gas line, the first gas line being in fluid communication with the on-axis outlet but not with the off-axis outlets and the second gas line being in fluid communication with the off-axis outlets but not with the on-axis outlet." Therefore, the plasma processing system recited in dependent Claim 15 also is patentable for at least the same reasons that Claim 1 is patentable.

Therefore, withdrawal of the rejection is respectfully requested.

New Claims

Claims 43-48 depend from independent Claims 1, 7, 9, 10, 41 and 42 and recite the features that "the system is a plasma etching system." Support for the subject matter recited in Claims 43-48 is provided, for example, at page 8, lines 16-

17 of the specification. In contrast, Chang discloses an HDP-CVD deposition system.

Claim 49 depends from Claim 9 and recites the features that “the off-axis outlets are circumferentially spaced apart from each other at an angle of 45°, 90° or 120°.” Support for the subject matter recited in Claim 49 is provided at page 14, lines 6-11 of the specification. Claim 49 also is patentable for at least the same reasons that Claim 9 is patentable.

Claim 50 depends from Claim 1 and recites the features that “the common gas supply comprises a single third gas line in fluid communication with the first gas line and the second gas line.” Support for the subject matter recited in Claim 50 is provided, for example, in Figures 2a-2c of the drawings. As explained above, Chang's system is constructed such that a separate gas source is connected to each of the top nozzle 96 and top vent 98. Also, Chang teaches away from any modification of the system to achieve the system recited in Claim 50.

Claim 51-55 depend from Claims 1, 7, 9, 41 and 42, respectively, and recite the features that each of the gas outlets includes “an interior orifice contoured to provide sonic or supersonic flow therethrough.” Support for the subject matter recited in Claims 51-55 is provided, for example, at page 16, lines 4-11 of the specification. The systems recited in Claims 51-55 are further patentably distinguishable over the cited combinations of references.

Claim 56-61 depend from Claims 1, 7, 9, 10, 41 and 42, respectively, and recite the features that at least one of the gas outlets “has a uniform diameter along the entire length thereof.” Support for the subject matter recited in Claims 56-61 is provided, for example, at page 18, lines 17-19 of the specification. The systems

recited in Claims 56-61 are also further patentably distinguishable over the cited combinations of references.

Conclusion

Therefore, allowance of the application is respectfully requested. Should the Examiner need to discuss this application, the undersigned attorney can be reached at the telephone number given below

Respectfully submitted,

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